

UNITED STATES OF AMERICA
DEPARTMENT OF COMMERCE
OFFICE OF THE ADMINISTRATOR OF CIVIL AERONAUTICS
WASHINGTON 25, D. C.

TSO-C26 effective
March 15, 1952

TECHNICAL STANDARD ORDER

SUBJECT: AIRCRAFT WHEELS AND BRAKES

INTRODUCTION

Under Section 601 of the Civil Aeronautics Act of 1938, as amended, and Parts 3, 4a, 4b and 6 of the Civil Air Regulations issued pursuant thereto, the Administrator of Civil Aeronautics is authorized to adopt standards for wheels intended for installation on civil aircraft. In adopting these standards, consideration has been given to existing Government and industry standards for the minimum strength and performance requirements for wheels intended for use on civil aircraft. This Technical Standard Order is intended to serve as a criterion by which the product manufacturer may produce wheels which will meet standards acceptable to the Civil Aeronautics Administration. In lieu of the above procedure, wheels may be approved as part of the aircraft design, in which case, the aircraft manufacturer should submit the pertinent wheel drawings and include them on the aircraft drawing list. Such wheels shall comply with the strength and performance requirements for wheels as stated in this Order, and the approval thereof will be recognized by all Civil Aeronautics Administration representatives.

The above is also applicable to wheel-brake combinations when the regulations require that a brake shall be rated on a basis of kinetic energy capacity in order to make it eligible for use on transport category aircraft.

DIRECTIVE

Provision. The strength and performance requirements for wheels and brakes as set forth in Sections 4 and 5 of the Society of Automotive Engineers, Inc., Aeronautical Standard Specification AS-227A dated February 1, 1952*, with the exceptions hereinafter noted, are hereby established as minimum safety standards for wheels or wheel-brake combinations intended for use as main or nose wheels on civil aircraft.

EXCEPTION:

Wheels or wheel-brake combinations for non-transport category aircraft and rotorcraft need not comply with Sections 5.2(d), (e), (f) and (g), 5.4.3, 5.4.5, 5.4.6 and 5.4.7 of the above-mentioned specification. These sections pertain to brake tests and a wheel roll test.

*Copies may be obtained from the Society of Automotive Engineers, 29 West 39th Street, New York, New York.

Application. Wheels or wheel-brake combinations complying with the specifications appearing in this Order are hereby acceptable for use on civil aircraft.

Wheels or wheel-brake combinations already approved by the Administrator may continue to be installed by the aircraft manufacturer on production aircraft:-

- (1) for which an application for original type certificate is made prior to the effective date of this Order;
- (2) the prototype of which is flown within one year after the effective date of this Order; and
- (3) the prototype of which is not flown within one year after the effective date of this Order if due to causes beyond the applicant's control.

If an alteration or replacement involving a change in type or model of wheels or wheel-brake combinations is made, or if an original installation on an individual airplane is made, previously type certificated wheels or wheel-brake combinations may be installed.

SPECIFIC INSTRUCTIONS

Marking. In addition to the identification information required in Section 3.2 of Specification AS-227A (except that "AS-227" is not required), each wheel and wheel-brake combination shall be permanently marked with the Technical Standard Order designation, CAA-TSO-C26, to identify the wheel as meeting the requirements of this Order in accordance with the manufacturer's statement of conformance described below. This identification will be accepted by the Civil Aeronautics Administration as evidence that the established minimum safety requirements for the wheel have been met. For wheel or wheel-brake combinations approved as part of the aircraft design, no identification marking other than the aircraft manufacturer's part or drawing number is required.

The above is also applicable to wheel-brake combinations when the regulations require that a brake shall be rated on a basis of kinetic energy capacity in order to make it eligible for use on transport category aircraft.

Data Requirements. None.

Effective Date. After March 15, 1952, specifications contained in this Order will constitute the basis for Civil Aeronautics Administration approval of wheels or wheel-brake combinations for use on certificated aircraft.

Deviations. Requests for deviation from, or waiver of, the requirements of this Order, which affect the basic airworthiness of the component, should be submitted for the approval of the Chief, Aircraft Engineering Division, Office of Aviation Safety, Civil Aeronautics Administration. These requests should be addressed to the nearest Regional Office of the Civil Aeronautics Administration, Attention: Chief, Aircraft Engineering Branch.

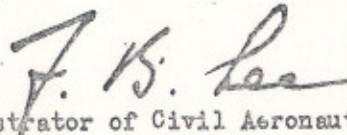
Conformance. The manufacturer shall furnish to the CAA, Aircraft Engineering Division, Attention: W-298, Washington 25, D. C., a written statement of conformance signed by a responsible official of his company, setting forth that the designated

wheel or wheel-brake assembly to be produced by him meet the minimum safety standards established in this Order. Immediately thereafter, distribution of the wheels or wheel-brake assemblies conforming with the terms of this Order may be started and continued. A statement of conformance is not required for wheel or wheel-brake assemblies approved as part of the aircraft design.

The prescribed identification on the wheels or wheel-brake assemblies does not relieve the aircraft manufacturer or owner of responsibility for the proper installation of the wheels or wheel-brake assemblies on his aircraft, nor waive any of the requirements concerning type certification of the aircraft in accordance with existing Civil Air Regulations.

If complaints of nonconformance with the requirements of this Order are brought to the attention of the Civil Aeronautics Administration, and investigation indicates that such complaints are justified, the Administrator will take appropriate action to restrict the use of the product involved.

Copies of this Technical Standard Order and other Technical Standard Orders may be obtained from the Civil Aeronautics Administration, Aviation Information Office, Washington 25, D. C.



Acting Administrator of Civil Aeronautics

WHEELS AND BRAKES
MINIMUM REQUIREMENTS FOR CIVIL AIRCRAFT APPLICATIONS

Issued 8-1-50
Revised 2-1-52

1. **PURPOSE:** To specify minimum requirements for Aircraft Wheels and Brakes for civil aircraft applications.
2. **SCOPE:** This specification covers minimum requirements for wheels and brakes in a range of sizes to accommodate the sizes and types of standard casings.

3. **GENERAL REQUIREMENTS:**

3.1 **Materials and Workmanship:**

3.1.1 **Materials:** Materials shall be suitable for the purpose intended. All metals used in the construction of wheels and brakes shall be corrosion resistant unless suitably plated or treated to resist corrosion during stocking and normal service life. The use of dissimilar metals, especially brass, copper, or steel in contact with aluminum, magnesium or alloys thereof shall be avoided where practicable.

3.1.2 **Workmanship:** Workmanship and finish shall be in accordance with high grade aircraft wheel and brake manufacturing practice.

3.2 **Identification:** Each wheel and each brake assembly shall be plainly marked as follows, and as applicable, in accordance with the ratings selected:

	Wheel	Brake
(a) AS-227	X	X
(b) Size	X	
(c) Serial number and date of manufacture	X	X
(d) Manufacturer's name and drawing number	X	X
(e) Maximum static rating of wheel	X	

Markings shall be of such character that they will not be obliterated or effaced as a result of service usage.

4. **DETAIL REQUIREMENTS:**

4.1 **Design:**

4.1.1 **Brake Fluid:** All hydraulic brakes shall be designed and tested to operate with hydraulic brake fluid or oil specified for the airplane on which the brakes are used.

4.1.2 **Lubricant Retainers:** Suitable retainers shall be provided to prevent lubricant from reaching the braking surface and to prevent foreign matter from entering the bearings.

Section 7C of the SAE Technical Board rules provides that: "All technical reports, including drafts approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to publish or to use any SAE standard recommended practice, and no commitment to conform to or be guided by any technical report, in formulating and approving technical specifications. The Board and its Committees will not investigate or consider patents which may claim to the subject matter. Prospective users of the report are responsible for protecting themselves against infringement of patents."

A 227A

Issued 8-1-50
Revised 2-1-52WHEELS AND BRAKES
MINIMUM REQUIREMENTS FOR CIVIL AIRCRAFT APPLICATIONS

- 2 -

4.1.3 Removable Flanges: All removable flanges shall be assembled to the wheel in a manner that will prevent the removable flange and its retaining device from leaving the wheel in case a flat tire occurs while the wheel is rolling.

4.1.4 Adjustment: When necessary to insure safe performance, the brake mechanism shall be equipped with suitable adjustment devices.

4.2 Amphibian Applications:

4.2.1 Water Seal: Provision shall be made to seal the wheels of amphibious aircraft to prevent entrance of water to the wheel bearings or other portions of the wheel or brake where the presence of water might be detrimental. Unsealed brake assemblies will be permitted if all exposed materials therein are corrosion resistant or the design is such that brake action and service life will not be impaired by the presence of sea water or fresh water.

4.3 Construction:

4.3.1 X-Ray Control: Castings shall be produced under X-Ray control when a new Foundry source is established, when new size or shape castings are made, or when a change is made in foundry technique.

4.3.2 Castings: Castings shall be of high quality, clean, sound, and free from blowholes, porosity, or surface defects caused by slag inclusions, except that loose sand or entrapped gases may be allowed when the serviceability of the casting has not been impaired.

4.3.3 Rim Surfaces: The surface of the rim between bead seats shall be free from defects or casting protrusions which will be injurious to the inner tube. Acceptable depressions in rim or bead seats which might injure the tube or casing shall be filled with a hard surface permanent filler before the primer coat is applied. No holes which extend entirely through the casting shall be filled in this manner, but shall be drilled out and filled with a flush plug.

4.3.4 Rim Joints: Joints in the rim surface and joints between rim surfaces and demountable flanges shall be smooth, close-fitting, and non-injurious to the inner tube during mounting the tire or in service.

4.3.5 Rivets and Bolts: When rivets are used, they shall be well headed-over, and rivets or bolts coming in contact with the casing or tube shall be smooth enough not to damage the tube or casing during normal operation.

4.3.6 Bolts and Studs: When bolts and studs are used for fastening together sections of a wheel, the length of the threads for the nut extending into and bearing against the sections shall be held to a minimum, and there shall be sufficient unthreaded bearing area to carry the required load.

WHEELS AND BRAKES
MINIMUM REQUIREMENTS FOR CIVIL AIRCRAFT APPLICATIONS

Issued 8-1-50
Revised 2-1-52

AS227A

- 3 -

4.4 Protective Treatment:

- 4.4.1 Steel Parts: Wherever possible all steel parts, except braking surfaces and those parts fabricated from corrosion resistant steel, shall be cadmium plated or zinc plated. Where cadmium or zinc plating cannot be applied, the surface shall be thoroughly cleaned and suitably protected from corrosion.
- 4.4.2 Aluminum Parts: All aluminum and aluminum alloy parts shall be anodized or have equivalent protection from corrosion.
- 4.4.3 Magnesium Parts: All magnesium alloy parts shall receive a suitable dichromate treatment or have equivalent protection from corrosion.
- 4.4.4 Bearings and Braking Surface: The bearings and braking surfaces shall be protected during the application of finish to the wheels and brakes.
- 4.4.5 Operating Cylinders: Prior to inspection tests, the cylinders shall be suitably cleaned to remove all metal particles and other foreign matter. The cylinder ports shall be suitably capped to prevent entrance of foreign matter.

5. QUALIFICATION TESTS:

- 5.1 Ratings: Each design of wheel or wheel-brake assembly shall have the following ratings as applicable:

S - Maximum Static Load in Pounds
L - Maximum Limit Load in Pounds (L = S times the limit landing load factor determined from drop tests)
K.E. - Maximum Kinetic Energy Capacity in Foot-Pounds
V_{so} - Minimum Stalling Speed in M.P.H.

- 5.2 Tests Required: Except as qualified by 5.3, the ratings for wheel and wheel-brake assemblies shall be substantiated by the following tests as applicable:

- (a) Radial Load
 (1) Limit
 (2) Ultimate
(b) Side Load
 (1) Limit
 (2) Ultimate
(c) Burst
(d) Dynamic Torque
(e) Structural Torque
(f) Static Pressure
(g) Roll

- 5.3 Exceptions: Ratings for wheels, and wheel-brake assemblies shall be substantiated by all the tests described in 5.2 with the following exceptions:

- 4 -

- (a) Tail wheels need not be roll tested.
- (b) When wheels are used for rotorcraft, they may be given a static load rating of 1.5 times S.
- (c) Overload stops under dynamic torque test (5.4.3b) applies only to wheel-brake assemblies for use on transport airplanes certificated in accordance with Civil Air Regulations Part 04b.

5.4 Test Requirements and Methods:

5.4.1 Radial Load Test: This test shall consist of the application of a load equally on both sides of the wheel, to a straight axle passing through the hub, with the tire restrained against a flat non-deflecting surface so that the point of application of the resisting force is centered midway between two spokes. In applying this load, the tire may be inflated with water to the specified pressure and the water gradually bled out as the load is increased so that the pressure in the completely deflected tire will equal that of the completely deflected air inflated tire.

- (a) A maximum radial limit load shall be determined by test by loading the wheel assembly to the yield radial load (115% of maximum radial limit load) for three separate applications at the same point on the wheel. Successive loadings shall not cause radial permanent set increments of increasing magnitude, and permanent set increment caused by the third loading shall not exceed 5% of the total deflection under that load. Deflections and permanent set readings shall be taken at a suitable point on the wheel to indicate deflections of the wheel rim at the bead seat.

The wheel manufacturer shall select the limit load for which the wheel assembly will be rated.

- (b) After determining the maximum radial limit load, the load shall then be increased at least to the ultimate load which is 1.875 times the maximum radial limit load. The wheel shall support the ultimate load for at least three seconds without failure.

For forged wheels of either ferrous or non-ferrous alloys, the ultimate load may be considered to be 1.5 times the maximum radial limit load.

5.4.2 Side Load Test: This test shall consist of the application of a load to the ~~critical ends~~ of the wheel in a direction parallel to the axis of the wheel hub, to the side of the tire casing by means of a block which shall cover an arc of not more than 60 degrees and whose centroid shall fall on a point midway between the rim flange O.D. and the nominal tire O.D. In applying this load, the wheel shall be restrained only by the axle and the tire may be inflated with water to any pressure, not exceeding the burst test pressure, necessary to accomplish the test.

- 5 -

- (a) A side limit load of at least 40% of the maximum radial limit load shall be determined by test by loading the wheel assembly to the yield side load (115% of the side limit load). The requirements for loading and permanent set shall be the same as outlined in paragraph 5.4.1.
- (b) After determining the side limit load, the load shall then be increased at least to the ultimate load which is 1.875 times the side limit load. The wheel shall support the ultimate load for at least three seconds without failure.

For forged wheels of either ferrous or non-ferrous alloys, the ultimate load may be considered to be 1.5 times the side limit load.

5.4.3 Dynamic Torque Test: This test shall be performed on a suitable inertia brake testing machine and shall consist of:

- (a) 100 brake applications of the wheel-brake assembly simulating the stopping of an airplane from an initial braking speed of V_{so} at an average deceleration of not less than 10 feet per second per second such that the kinetic energy absorbed per stop is not less than the K.E. as determined under Item "C" below.

Where necessary, to allow for dynamometer limitations, the initial braking speed and deceleration may be varied to give an equivalent energy absorption rate.

- (b) 3 additional brake applications performed in accordance with (a) above, except that the initial wheel speed shall be increased sufficiently to obtain a kinetic energy absorption per stop of not less than 1.25 K.E.
- (c) The kinetic energy of the wheel-brake assembly shall be calculated as follows except in cases where there is an unequal distribution of braking between main landing wheels:

$$K.E. = \frac{.0334 W V_{so}^2}{N}$$

Where K.E. = Kinetic energy per wheel, ft. lbs.
W = Design landing weight, lbs.
 V_{so} = Power off stalling speed, mph at sea level at weight (W) and landing configuration
N = Number of main wheels

The assembly shall withstand the test outlined under (a) and (b) without failure, impairment of serviceability or effectiveness, and without requiring undue maintenance. One change of lining is permissible in meeting the above tests.

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§ 46.337-3
(a)(i)(i)

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§ 46.337-3
(a)(i)(ii)

- 6 -

- 5.4.4 Burst Test: This test shall consist of a load imposed on the wheel by a hydrostatic tire pressure equal to four times the normal inflation pressure required for static load (S). The wheel shall withstand this test without failure.
- 5.4.5 Structural Torque Test: The test shall consist of the application of a torque load tangentially to the wheel at radius (R), the normal rolling radius of the tire under rated static load (S). In applying this load, rotation of the wheel shall be prevented by a force transmitted through one brake but need not consist solely of the brake friction force. The wheel-brake assembly shall withstand either a torque load not less than 1.6 SR/B , where B is the number of brakes per wheel, for at least 3 seconds without failure, or 80% of this value without permanent set.
- 5.4.6 Static Pressure: The brake shall withstand a pressure equal to twice the maximum operating pressure for at least 3 seconds without failure. The maximum operating pressure is the pressure required to hold statically a torque of not less than $.55 \text{ SR}$ applied to wheel and shall be determined during these tests.
- 5.4.7 Roll Test: Wheel with tire installed shall withstand without failure or development of fatigue cracks that indicate inadequate design a roll of 1000 miles under a load not less than the static rating of the wheel as selected by the manufacturer.
6. DESIRABLE FEATURES (Not Mandatory):
- 6.1 Roll Test: For certain types of service it may be desirable to subject the wheels of a roll test greater than 1000 miles in order to increase service life. This is considered desirable for wheels to be used in domestic air carrier type operations. In such cases the exact conditions of test should be determined by agreement between the wheel manufacturer and the user.